Status and conservation of Solution Lakes in New Brunswick

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ABSTRACT

The status of the cave habitat in New Brunswick is examined and threats that face the 15 caves known to occur in the province are discussed. Methods of cave protection relevant to New Brunswick are considered and one gypsum cave lying within the boundaries of a proposed ecological reserve is recommended for protection. Although most New Brunswick solution caves are not immediately threatened, the best known caves have been vandalized and the entrance to one of the longest provincial caves has been sealed. Three solution caves and a tectonic rift cave have been identified as major New Brunswick hibernacula for the bats Myotis lucifugus (Little Brown Bat) and M. keenii* (Keens Myotis) while the much rarer bat Pipistrellus subflavus (Eastern Pipistrelle) has been recorded from four solution caves in the province. New Brunswick caves have received some attention from recreational cavers; such use, however, may conflict with their value as bat hibernacula.

* = Myotis septentrionalis (Trouessart 1897); van Zyll de Jong 1979.

RESUMÉ

Cette étude nous indique où en est l'état du biotope des cavernes au Nouveau-Brunswick et se penche sur les dangers qui ménacent les 15 cavernes connues de la province. On y traite des methodes relatives à leur protection et on recommande qu'une caverne de gypse située à l'intérieur d'un site proposé comme réserve naturelle soit protégée. Bien que la plupart des cavernes du Nouveau-Brunswick ne soient pas en danger immédiat, les cavernes les mieux connues ont déjà subies des actes de vandalisme, alors que l'entrée d'une des plus longues d'entre elles a été scellée. Trois cavernes formées par dissolution et une creusée par déformation tectonique ont été identifiées comme hibernacles importants pour les espèces de chauve-souris Myotis lucifugus (Petite Chauve-souris brune) et M. Keenii* (Chauve-souris de Keen), alors que la présence de l'espèce Pipistrellus subflavus (Pipistrelle de l'Est), beaucoup plus rare, a été rapportée dans quatre des cavernes formées par dissolution. Les cavernes du Nouveau-Brunswick ont attiré l'attention occasionnelle de spéléologues amateurs; leurs intérêts, rappelons-le, pourraient rentrer en conflit avec ceux des chauve-souris qui y habitent.

* = Myotis septentrionalis (Trouessart 1897); van Zyll de Jong 1979.

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INTRODUCTION

The purpose of this document is threefold: to point out how little is known concerning New Brunswick caves; to draw the attention of those in government and environmental organizations to the rarity of the cave habitat in New Brunswick and to examine the problems of conserving cave ecosystems in this Province.

In their natural state, caves are often breathtakingly beautiful, but this is not their only value. The simplicity of these ecosystems makes them especially useful to science. Cave habitats may be manipulated to help gain an understanding of ecosystem dynamics, and they offer interesting opportunities for the study of adaptive processes, particularly in regions where strictly cave-inhabiting organisms occur. Many caves serve as important roosts for bats and caves have frequently yielded rich archaeological harvests on the past fauna of regions. Unfortunately on a worldwide scale caves are rare, and in New Brunswick, where there are few areas geologically suitable for cave formation, these valuable yet fragile environments are particularly uncommon.

In Part I of this paper I examine threats to New Brunswick caves and their contents, and in Part II I discuss the means of cave protection that might be employed in New Brunswick. In Part III recommendations are presented for the conservation of New Brunswick caves. A brief glossary of definitions is appended to acquaint the reader with cave-related terms appearing in the text (noted by an asterisk*).

About 100 caves* are known to occur in Ontario (MacGregor 1976), 100+ in Quebec (Beaupré et al 1976) and 26 in Nova Scotia (Moseley 1976). About 600-700 caves have been explored in western Canada and it is in this region that the longest (15,200 m) and deepest (533.1 m) Canadian caves occur (Anonymous 1980, Anonymous 1983). Although Bailey (1904) recorded a variety of verbal references to New Brunswick caves, less than twenty solution caves have been reliably documented in the province (McAlpine 1979 and Table 1). Others, undoubtedly, await discovery. All the New Brunswick solution caves have been found in the Precambrian limestones of the Greenhead group and in the Mississippian limestones and gypsums of the Windsor Group in the southern portion of the Province (Figures 1 and 2). There is one known tectonic* rift cave, originally described in error as a solution cave (Forney 1964), which is found in Fundy National Park.

Cave map surveying has been frequent in western Canada and Quebec where there has also been some study made of regional karst* hydrology and geomorphology. However, for Canada as a whole there is extremely little published information concerning the ecology of the cave habitat. In New Brunswick map surveys have been carried out by McAlpine (1976a, 1982), Moseley (1976a) and Schroeder and Arsenault (1978). McAlpine (1979), and McAlpine and Reynolds (1977) have briefly examined the ecology and Schroeder and Arsenault (1978) the geomorphology, of selected New Brunswick solution caves.

Table 1: Information on known New Brunswick tectonic and solution caves

CAVE NAME(S)	COUNTY	GEOLOGY	LENGTH (m)[1]	DEPTH (m)[1]	BATS[2]	REMARKS
1. Howes (Olivers)	St. John	Precambrian Limestone	80	13	A,D,E	Interesting invertebrate fauna; vandalized.
2. Harbells	St. John	Precambrian Limestone	73.5	15	A,D,E	Active sinking stream in Rockwood Park
3. Greenhead	St. John	Precambrian Limestone	64.0	26.7	A,E,F	Entrance on cliff face, litte fauna; vandalized.
4. Kitts	Kings	Mississippian Limestone	154	(8)	A,F	Active stream cave.
5. Parlee Brook	Kings	Mississippian Limestone	?	?	?	Active stream cave.
6. Hamilton	Kings	Mississippian Limestone	15.2	?	?	Rich fauna due to large amount of detritus.
7. Glebe Pot	Kings	Mississippian Limestone	15.2	12.5	Nil	Pot hole type cave.
8. Waterford Ice Cave	Kings	Mississippian Limestone	?	?	?	
9. Archie's Hole	Kings	Mississippian Limestone	(2700)	?	?	Entrance now blocked; longest known New Brunswick Cave.
10. Underground Lake	Albert	Mississippian Gypsum	(20+)	?	B,D,E,F	See Recommendations, some vandalism.
11. Gypsum	Albert	Mississippian Gypsum	102	8.3	?	Little invertebrate fauna.
12. Bat	Albert	Mississippian Gypsum	83	?	C,D,E	Little invertebrate fauna; porcupine-inhabited.
13. Shaft	Albert	Mississippian Limestone	12.9	11.2	Nil	Close to Turtle Creek Cave.
14. Turtle Creek (Stewart, Stuart)	Albert	Mississippian Limestone	(300+)	?	C,D,E,F	
15. Rift (Acadia Cavern)	Albert	Mississippian & Pennsylvanian Shales Sandstone and congolomerate	?	(50)	B,D,E	Tectonic cave arising through gravity sliding; in Fundy Park.

1. Estimates in parentheses; 2. A. 1-25; B. about 150; C. over 300; D. Myotis lucifugus; E. M. keenii; F. Pipistrellus subflavus.

PART I - THREATS TO NEW BRUNSWICK CAVES

The discussion that follows is concerned largely with solution caves, although reference is also made to a single cave of tectonic origin, and some comments may be applicable to abandoned mines that serve as caves in an ecological context. Moseley (1975) has examined the difficulties of cave conservation in Nova Scotia and this discussion leans heavily on his study of the problem in that province. Although gypsum caves predominate in Nova Scotia, while most of New Brunswick's known caves have developed in limestone, the problems in the two provinces are largely the same: a small number of caves representing unique provincial habitat, little knowledge on which to base cave conservation policies, and vandalism.

1.1) Mining and mineral exploration may have the following negative effects on caves (Anonymous 1980):

- road development (blasting or infilling) too near caves promoting subsidence, collapse or alteration of entrances;
- alteration of stream channels, flow and water quality;
- alteration of ground water flow;
- stream flushing or dumping of debris into caves;
- total or partial collapse or excavation of a cave system;
- increase in accessibility of specific caves;
- sediment laden streams scouring cave features and clogging passages.

Gypsum and limestone mining presents the obvious threat that caves may be quarried away. The present entrance to Green Head Cave was probably exposed during quarrying operations in the 1800's, before which the cave may well have been considerably

longer. There is no production of gypsum in New Brunswick at this time, the Canada Gypsum Company having terminated operations at Hillsborough late in 1980. Limestone production in New Brunswick for 1981 was 794,326 tonnes, a relatively small proportion of the total Canadian output (61,953 kt. in 1979, J.B. Hamilton pers. comm.). So far, no New Brunswick cave has been totally destroyed as a result of quarrying, but the danger that quarrying the very restricted areas of limestone and gypsum might pose to caves must be considered. Also of concern is damage caused by shockwaves from nearby quarry blasting, a continuing problem to a number of caves in Nova Scotia (Moseley 1976), although at present no known caves are threatened by blasting or quarrying in New Brunswick.

1.2) Forestry operations - Although large and small scale forestry activities occur throughout New Brunswick, there are no known instances where forestry operations threaten any New Brunswick cave. Nevertheless, the potential dangers are the same as those noted under Mining and Mineral exploration (Sec. 1.1).

1.3) Permanent closure of entrances - It is, unfortunately, quite easy to block a cave entrance simply by filling it in, and this is a measure frequently adopted by local authorities or farmers concerned with human and animal welfare. The concern of a landowner over his liability for injuries sustained in a cave on his property is understandable and should be treated with respect. In all such cases, gating, although a more expensive and more difficult method of closing off an entrance, should be encourage over filling, since correct gate installation leaves the ecosystem intact and allows for restricted access by authorized persons.

Thought to be the longest known cave in the Maritimes, Archie's Hole was blocked by the Canada Cement Company in 1969. This act was prompted by concern over legal liability following an incident where a teenage girl became trapped and had to be rescued by quarry personnel (Moseley 1973). Although Archie's Hole was never mapped or fully explored, references in the literature lead one to believe it is well over 2,700 m in length (Moseley 1973, Sclanders 1937). Attempts by the Nova Scotia Speleological Society to persuade company officials to open the entrance were not successful. No other New Brunswick caves are threatened by closure, but the tectonic rift cave in Fundy National Park, although not well known, is accessible and dangerous to enter. It is of some importance as a bat hibernaculum and should visitor safety pose a problem this cave should be gated rather than sealed.

1.4) Visitors to caves - Regardless of intention, the greatest damage to caves worldwide is caused by visitors. It is impossible to enter a cave without causing some change and usually this change is detrimental to the ecosystem. If each visitor is aware of the implications of his actions, much damage can be avoided. Because New Brunswick caves are few, and short, caving has never been a popular sport here, and as a result caving groups have been ephemeral, poorly equipped and ignorant of the sensitivity of the environment they enter. A number of caves have been seriously damaged by visitors, most notably Howes Cave (McAlpine 1976a). This cave is strewn with broken glass, paper and plastic, and many of the walls have been disfigured with etched names and spray-painted graffiti. The following is a discussion of the specific kinds of damage visitors pose to New Brunswick caves.

Figure 1. Areas of Precambrian limestone (stippled) and Mississippian limestone and gypsum (solid black) in New Brunswick where solution caves are known or expected to occur.

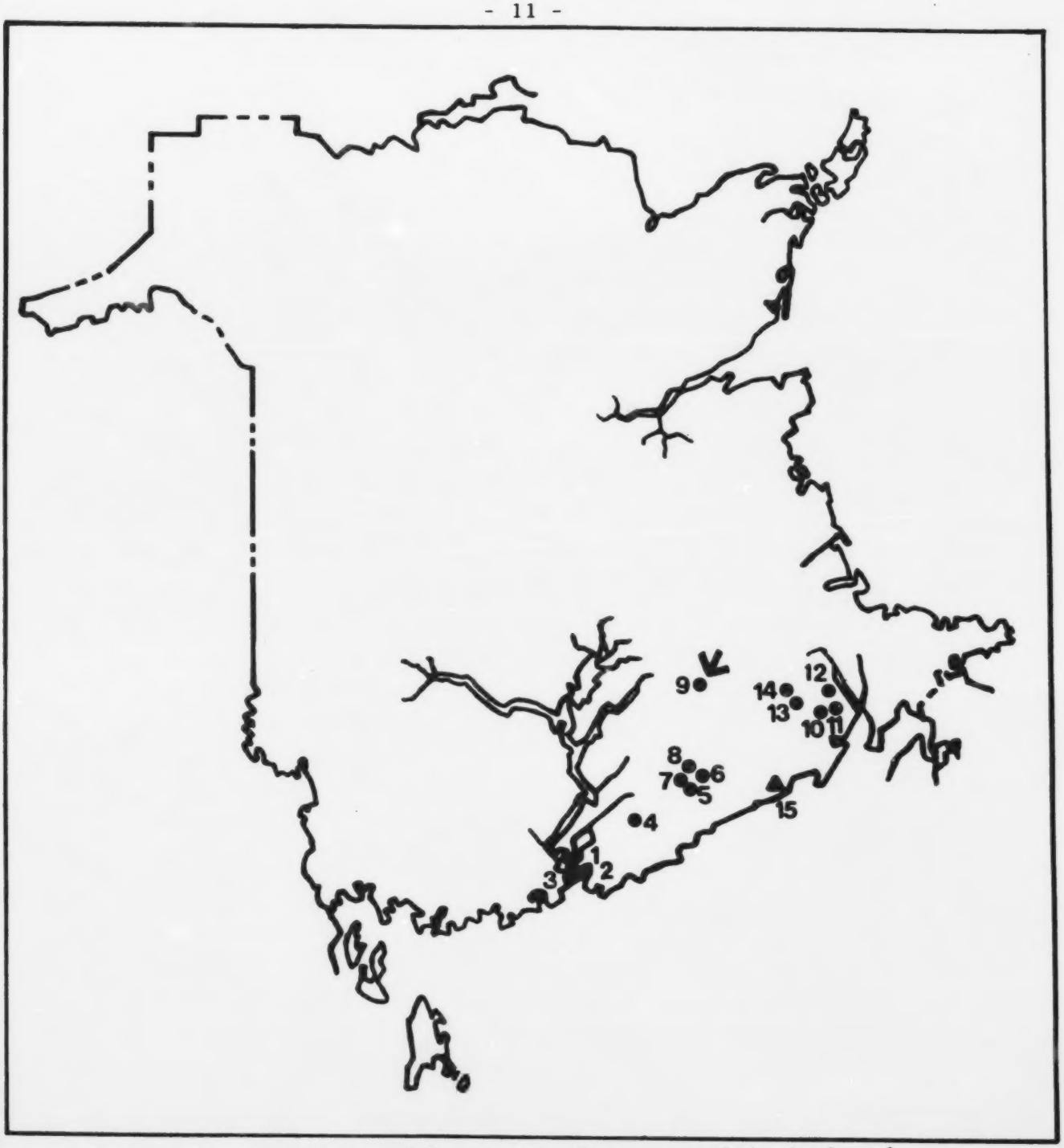

Figure 2. Locations of known solution caves (circles) and tectonic rift cave (triangle) in New Brunswick. Arrow indicates Archie's Hole, the entrance to which is now blocked. Numbers refer to caves noted in Table 1.

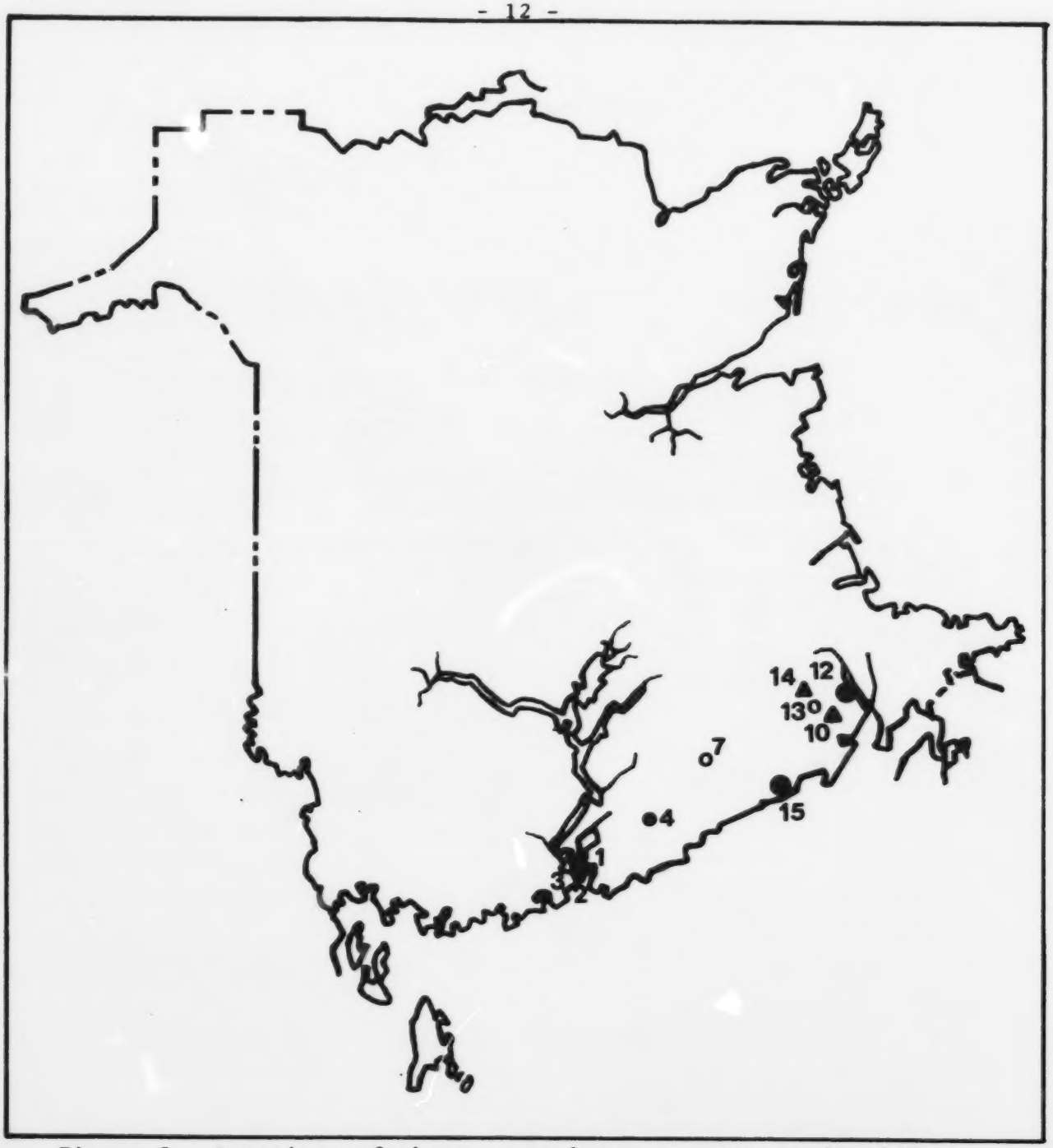

Figure 3. Locations of those caves known to serve as bat hibernacula in New Brunswick. Small open circles show caves at which no bats have been observed, while small solid circles show caves at which 1-25 individuals have been recorded. Large solid circles represent caves containing approximately 150 bats, while triangles show caves where over 300 bats have been observed. See Table 1 for species involved at each site.

1.4a) Disturbance of bats is probably one of the most serious threats that visitors to New Brunswick caves present. A decline in numbers of hibernating bats has recently been noted in one New Brunswick gypsum cave (McAlpine 1979). Apparently Howes Cave at one time harboured large numbers of hibernating bats but few bats now use this well-known cave (McAlpine 1979). Some banding of New Brunswick bats has been carried out (W.B. Stallworthy pers. comm. and N.B.M. files) but we know very little about New Brunswick bat populations or the reasons for their apparent decline. All records for the Eastern Pipistrelle (Pipistrellus subflavus) in New Brunswick are from solution caves or abandoned mines. Visitors can rarely enter caves containing hibernating bats without causing some disturbance, which need not be frequent to result in significant weight loss and increased mortality among the bats. Visitors should refrain from entering major bat hibernacula in New Brunswick during the hibernation period, the exact extent of which has not been determined (October to May approximately).

1.4b) Forcing entry to unexplored caves, creating extensions of known caves, or modifying entrances to provide easy and " safe" access for visitors by digging or blasting, may all alter air flow. Changes in air flow result in shifts in humidity and temperature that are often destructive to cave fauna and formations. Hibernating bats are particularly sensitive to environmental changes. Sites of possible archaeological interest may also be destroyed and damage to laminated cave sediments and cave morphology may be considerable.

1.4c) Carbide dumping - Most individuals caving in New Brunswick are now using electric light sources. Carbide lamps, in which acetylene gas produced by mixing water with carbide is ignited and burns at a jet positioned in a reflector, are occasionally used by cavers in New Brunswick and are used for soot marking survey stations during cave mapping. Although carbide dumping does not appear to be a problem in New Brunswick caves it should be noted that spent carbide dumped in caves is often toxic to cave organisms.

1.4d) Scientific collecting - In many parts of the world cave-inhabiting organisms are endemic to individual cave systems or even to single caves. There are no endemic cave species in New Brunswick and only recently have two species of subterranean amphipod and an isopod been described from western Canadian caves (Bousfield and Holsinger 1981, Bowman 1975, Holsinger 1980). The likelihood that endemic cave species will be discovered in New Brunswick is small. Nevertheless, New Brunswick caves harbour a characteristic fauna of which very little is known. Because of the small numbers and low reproductive potential of many cave populations scientific collecting can be disastrous. The use of bait in collecting fauna is particularly risky because it may attract relatively large numbers of individuals. Collecting bats for research has contributed to reduce populations in some parts of the world, although it has not, to my knowledge, been a factor in the apparently declining bat populations in New Brunswick caves. Removal of mineral specimens and speleothems* damages a cave from both a scientific and aesthetic point of view. Speleothem development in New Brunswick caves is poor but many of the few examples have been damaged or removed by visitors.

1.4e) Vandalism - Drawing a line between deliberate vandalism and damage through ignorance may be difficult. Breaking formations, killing bats and spray painting graffiti can all be considered acts of vandalism. Both Howes Cave and Green Head Cave have been disfigured by etched and spray-painted graffiti and are littered with the refuse of visitors. Undoubtedly intentional disturbance of bats has occurred in some New Brunswick caves and may be, in part, the cause of the observed decline in hibernating bats.

1.4f) Public and commercial use of caves - Characteristically, New Brunswick caves are short, usually under 150 metres in length, and they would seem to present few challenges for the sport caver. Nevertheless, New Brunswick caves have attracted the sporadic attention of a small number of recreational cavers, most notably the Nova Scotia Speleological Society, and a number of popular accounts of cave exploration in New Brunswick have appeared (Nova Scotia Speleological Society Newsletter and Bulletin 1973-1977, Burzynski 1981, Majka 1979). There are no commercially operated caves in New Brunswick, but Underground Lake Cave, Albert County, is advertised as an attraction through tourist literature, (Countyguide, Albert County Road Map and Tourist Guide). This cave is an important bat hibernaculum.

Obviously any " show-cave " owner has a vested interest in protecting his cave, but he may still modify the entrance to provide easy access. As has been noted, the resulting changes in air flow patterns may be harmful to the cave ecosystem. Caving trips have been organized to Howes Cave, Harbells Cave, and Turtle Creek Cave by the Saint John Boys and Girls Club Summer Wilderness Programme during June, July and August of 1980 - 1982 (total visits = 30-80 children per summer). In addition, two Saint John individuals giving wilderness skills seminars have led caving trips for paying groups of 2-15 in Howes Cave and Harbells Cave.

1.5) Ground Water contamination - Sinkholes and sinking streams* may serve as convenient sites for dumping solid or liquid wastes (see Sections 1.1 and 1.2). Effluents will often move rapidly through groundwater and not only may the cave ecosystem be destroyed but the surrounding water table may itself be contaminated. Moseley (1976b) notes that Buncker C Oil was accidentally introduced into Archie's Hole, Kings County, and surfaced 1.1 km from the entrance. As yet no other cases of groundwater contamination via caves, or influencing cave ecosystems, have been reported in New Brunswick.

PART II - METHODS OF CAVE PROTECTION

Detailed information concerning some of the problems of conserving caves and their associated fauna may be found in the Proceedings of the National Cave Management Symposia (Anonymous 1975), Aley and Rhodes 1976, Wilson and Lewis 1982). Recently there has been some interest in legislating cave protection in British Columbia (Anonymous 1980, 1981). To date, none of the solution caves discovered in New Brunswick have more than minor recreational value, or any significant potential as show caves. Most are short, muddy, wet, cold and uncomfortable to explore, and some are unsafe to enter due to the danger of falling rock. This is particularly true of the entrance areas in gypsum caves where frost action may produce hazardous conditions. Solution caves are rare in New Brunswick and representative samples of these provincial ecosystems should be protected where necessary. At least three solution caves also serve as important sites for hibernating bats. Options for the conservation of New Brunswick caves are discussed below.

2.1) Education of cave visitors is an important method of cave protection. In the United States the National Speleological Society serves an educational function and has provided the focus for many of the cave conservation efforts in that country. In New Brunswick, however, caving groups have been inexperienced and short-lived; this makes education difficult, while the lack of continuity among those caving reduces its value. The establishment of an organized caving group in New Brunswick seems unlikely at present. Nevertheless, the number of requests for information concerning New Brunswick caves that The New Brunswick Museum has received over the past two years would seem to indicate that some educational literature is desirable. When creating such literature it should, however, be taken into account that restriction of certain information is also a method of cave

protection (Sec. 2.5). A widely used and useful approach for alerting cave visitors to the fragile nature of the cave habitat and its contents is through posting interpretive/educational signs at cave entrances. Such an approach could prove valuable in protecting New Brunswick caves and cave bats.

2.2) Research - Development of a sound conservation policy depends upon information and so far there has been relatively little research carried out on New Brunswick solution caves. McAlpine (1979) reviewed the literature pertaining to New Brunswick caves and suggested avenues for further research. These include detailed faunal and micro-climate surveys, continuation of cave mapping efforts and investigations to determine the importance of New Brunswick caves as sites for bat hibernation. Since that review, cave mapping has continued but no further investigations have been initiated. Little, too, is known concerning New Brunswick bat populations, although nearly 700 bats (Myotis sp.) were banded at an abandoned mine near Dorchester between 1956 and 1963 by Dr. W.S. Stallworthy and students of Mount Allison University (N.B.M. files and pers. comm.). It was not until 1976, during an examination of Kitts Cave, that the Eastern Pipistrelle (Pipistrellus subflavus) was first recorded in New Brunswick (McAlpine 1976b). New Brunswick caves harbour a characteristic invertebrate fauna of relatively few species; deep dark-zone climates are stable and sources of energy (usually detritus or porcupine dung) entering cave systems can easily be identified. These properties combined suggest that New Brunswick solution caves offer exciting potential for field studies on invertebrate community structure and ecology.

2.3) Negotiation of access agreements - Moseley (1976) notes that where a cave is in danger of being blocked by a landowner, it is possible for a responsible organization to obtain a negotiation agreement to keep the cave accessible. Rights of access may demand that the organization agree to erect a gate or fence to protect livestock, hold the gate key, and obtain legal release of liability before permitting access to the cave. Such agreements have the advantage that it is possible to screen visitors and to prevent access at certain times, such as when bats are hibernating. Unfortunately, no organization in New Brunswick has expressed an interest in negotiating such agreements or in taking responsibility for controlling access. Had an organization or government agency been delegated these duties it might have been possible to prevent the blocking of Archie's Hole or at least to have carried out map and faunal surveys in the cave before closure.

2.4) Retention of natural protective features - Those caving in New Brunswick are rarely motivated enough to pass tight crawls, flooded zones or other natural barriers. For example, many who visit Howes Cave do not crawl down the narrow left passage and even Matthew (1904) only provided a sketch map for the right side of the cave; ice buildup at the entrance to Turtle Creek Cave makes entry to his cave extremely difficult during the winter and effectively protects the large number of hibernating bats within; winter entry to Green Head Cave demands ice climbing equipment and/or a 30 m rappel over a cliff face. Natural features may protect a cave by preventing the entry of inexperienced cavers and should be preserved whenever possible.

2.5) Restriction of information - Certainly one of the simplest and least expensive methods of protecting caves, restriction of information is a valuable method of reducing, although it does not eliminate, vandalism, and is well suited to present circumstances in New Brunswick. In accordance with this method, cave map surveys should be published without revealing exact locations and the discovery and exploration of new caves should be broadcast with discretion.

2.6) Gating - Complete protection of the bats that may be using caves for hibernation may necessitate cave gating. It is imperative that gates be installed in such a way as not to impede the entry or exit of bats or alter air flow (Hunt and Stitt 1975). Those installing gates should not underestimate the persistence of vandals. Hayes Cave, Nova Scotia, was gated in 1978 to protect the hibernating bats and within a month of installation the gates had been torn out by vandals (Scott 1979).

2.7) Legislation - There is no legislation in New Brunswick that deals specifically with cave protection and only the Ecological Reserves Act is directed towards protecting unique or rare habitats. A number of pieces of legislation, however, could conceivably be used to provide full protection for or to restrict access to caves in New Brunswick. The most obvious of these are briefly reviewed below.

Provincial Legislation

a) Endangered Species Act - A great deficiency in this Act is that it makes no provision for the protection of the habitat

of endangered animals, although the habitat of an endangered plant is protected. However, the Act does specify that no person shall kill, injure or harass any endangered species. Therefore, should any species inhabiting a cave in New Brunswick be designated as endangered under this Act some control over cave access might be possible. Obviously, a modification of this Act to include habitat protection for animal species would increase the value of the Act in cave protection.

b) Ecological Reserves Act - The Ecological Reserves Act controls access to a reserve, defines the level and type of use a reserve may have, and bans environmental contaminants from each reserve. This piece of legislation is well suited for protecting caves, although no New Brunswick cave has, as yet, been designated as an ecological reserve. Part III of this report recommends one cave for ecological reserve status (see page 23).

c) Historic Sites Protection Act - Should any New Brunswick cave be found to be of archaeological, anthropological or even historical significance and be so designated under this Act, access to and alteration of the cave can be controlled.

d) Clean Environment Act - This Act controls the contamination of water courses, including groundwater, by any kind of solid or liquid waste, as well as controlling the removal of sand, gravel, rock or vegetation from specified areas about the water course. The Act could be used to control or stop ground water contamination of caves that may not be protected under any other Act (e.g., Archie's Hole). In addition, any contamination that threatens " fish, animal or plant life" is covered by this Act.

Federal Legislation

a) National Parks Act - In National Parks General Regulations (Section 8, Restricted Activities and Areas) it is stated that no person shall enter any cave in a Park without written permission from the Superintendent, unless an authorized notice to the contrary is posted at the entrance to the cave. This regulation has engendered much animosity between cavers and the parks service in western Canada (see issues of Canadian Caver). Although it offers some protection to caves in parks, its effectiveness is obviously limited unless an official is stationed at the cave entrance to ensure its enforcement. Moreover, experienced cavers may ignore the regulation.

At present there is only one cave that falls within the jurisdiction of this Act - a tectonic rift cave in Fundy National Park. This is the only known cave within a New Brunswick National Park.

A drawback to the enforcement of the Restricted Activities and Areas section is that such action advertises a cave's presence and can attract much unwanted attention to the area from the casual park visitor.

PART III - RECOMMENDATIONS

1) Continued research to document the flora, fauna; ecology, and geomorphology of New Brunswick caves.

2) Field work to locate additional caves that serve as important bat hibernacula and research on hibernating bat populations.

3) Designation of one or more examples of a limestone or gypsum cave as an ecological reserve, giving preference to caves that have some importance as bat hibernacula.

4) The posting of interpretive/educational signs at the entrances to frequently visited or vandalized caves. Such signs should stress the rarity of the cave habitat and the importance of leaving hibernating bats undisturbed by suggesting cave visits be restricted to the summer months.

5) Official designation as an ecological reserve of recommended ecological reserve No. 70 (Wilson Brook Gypsum Cliffs) to provide some protection for Underground Lake Cave bat hibernaculum.

6) Removal of Underground Lake Cave from Albert County tourist literature.

7) Designation of an agency to negotiate restricted access to caves, and to arrange for salvage collecting and explorations of significant caves threatened with closure, particularly those that serve as major provincial sites for hibernating bats.

GLOSSARY

Cave - any natural cavity in the earth which connects with the surface, contains a zone of total darkness and is large enough to admit a human.

Gypsum - a sedimentary rock (primarily calcium sulphate) in which caves occur and which is softer and more soluble than limestone.

Karst - terrain with many sinkholes, disappearing streams, underground drainage and caves.

Limestone - a sedimentary rock composed primarily of calcium carbonate and readily dissolved by carbonic acid occurring naturally in ground water. Most caves develop in limestone.

Sinking strcam - stream entering an area of karst that loses all or part of its drainage underground.

Solution cave - cave formed largely by the actions of naturally occurring weak carbonic acid on dissolvable portions of limestone or gypsum.

Speleothem - generic name for all deposits of calcite, argnoite and gypsum. Includes stalagmites, stalactites, flowstone and other depositional formations.

Tectonic cave - cave formed by movement of the earth's surface.

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